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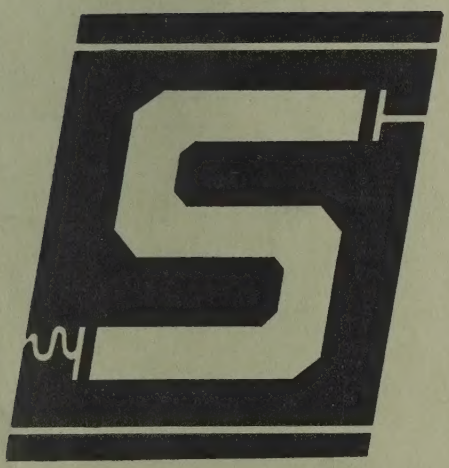
INSTRUCTION MANUAL

SERIAL MA-63

MODEL MA-65



SORENSEN & COMPANY, INC.

375 FAIRFIELD AVENUE, STAMFORD, CONN.

No. 113

INSTRUCTION MANUAL

SORENSEN "MA" NOBATRONS

SORENSEN & CO., INC., 375 Fairfield Avenue, Stamford, Conn.

GENERAL INFORMATION

Introduction

Before you begin to use your new Sorensen instrument we suggest that you read this Instruction Manual very carefully. The information contained herein is designed to help you obtain the maximum in performance and many years of dependable service from your instrument.

Shipping Damage

The instrument should be inspected and tested immediately upon arrival. In the event the unit fails to operate properly or is damaged in any way the carrier should be notified at once. When the claim agent has inspected the shipment and prepared a report of damage a copy of this report should be sent to us. At that time we will advise you concerning the repair or replacement of the instrument.

Service Information

All questions concerning the operation or malfunctioning of this instrument should be directed to the Service Department, Sorensen & Company, Inc., 375 Fairfield Avenue, Stamford, Conn.

IMPORTANT

BE SURE TO INCLUDE THE **MODEL** AND **SERIAL** NUMBER IN ALL CORRESPONDENCE CONCERNING THIS INSTRUMENT. WITHOUT THIS INFORMATION WE MAY NOT BE ABLE TO GIVE YOU PROMPT AND ACCURATE SERVICE.

IN THE EVENT OF DIFFICULTY

Should you receive a defective or damaged instrument or require service on an instrument within or outside of warranty, please write us. Be sure to include as much information as possible concerning the symptoms of difficulty, the application, input line voltage, etc. The more information you give us the faster we can handle your request.

In each case we will decide whether the instrument requiring service will be (a) returned to the factory, (b) shipped to a service station, or (c) serviced at your plant by one of our field engineers or representatives.

Shipments

If the instrument should be returned to the factory we will send you shipping instructions in the form of a Returned Material Tag. DO NOT SHIP A UNIT TO THE FACTORY WITHOUT THIS TAG.

Warranty

This instrument is warranted by Sorensen & Company, Inc., to be free from defects in material and workmanship. Our obligation to the original purchaser under the warranty is limited to servicing the instrument and replacing defective parts when the instrument is returned to the factory with transportation charges prepaid. No other warranties may be implied.

The period of warranty is one year after the date of delivery of the instrument to the original purchaser.

Uninstructed attempts at repairs, defects caused by improper operating conditions, accidents, misuse or negligence and the alteration or removal of the nameplate will void the warranty.

"MA" Nobatron Specifications

The MA Nobatron is a low voltage, high current, tubeless, regulated DC supply manufactured by Sorensen & Co., Inc.

MA Nobatrons are either self contained or designed for relay rack or cabinet mounting. Complete details on each model are given in the following specifications.

Following are the basic general specifications for MA Nobatrons. More details on electrical specifications will be found in Table I. and on mechanical specification (including controls) in Table II.

INPUT VOLTAGE

105 to 125 volts AC single phase (except MA28-50 which requires a three phase input of 190 to 230 or 210 to 250 volts).

Operation at lower or higher input voltages is possible with restrictions on the output voltage range and current rating. In general, operation at low input voltage is restricted at high output voltage and heavy load currents by the regulating range of the circuit. Conversely, operation at high input voltage is restricted at low output voltage and light load by the regulating range of the circuit. In addition, operation at high input voltage increases core loss of the transformers which must be compensated for by lower copper losses and hence lower output current.

Regulation is not guaranteed outside the 105 to 125 volt input range. Operation should not be attempted at higher than 135 volts input (270 on the MA28-50) to prevent exceeding the breakdown voltage rating of the various components.

INPUT FREQUENCY

60 cycles.

Operation over the range of 45 to 65 cycles is possible with restrictions on the input or output voltage range and output current ratings. In general, lower frequency operation with high input, low output and light load is restricted by the regulating range of the circuit. Operation under the same conditions of input and output voltage and with full load current results in increased transformer core losses which must be compensated for by lower copper losses. Conversely, operation at a higher frequency with low input, high output and heavy load is undesirable.

In addition to the above, it should be noted that the ripple voltage increases at lower frequencies. Also, the specified regulation accuracy applies only to 60 cycle operation and regulation against frequency change is not guaranteed.

OUTPUT VOLTAGE ADJUSTMENT

See Table I.

REGULATION ACCURACY

$\pm$1% for load and line changes combined from no load to full load over rated input voltage range. Note that the regulation accuracy applies to line and load combined so that if line and load are changed separately, the total regulation accuracy may be as good as $\pm$.5%. The changes against both line and load are as a rule uniform, so that if the output voltage is set with 115 volts input at half load, the maximum change for line would be .25% up at 125 volts half load and .25% down at 105 volts half load.

Due to the nature of the load compensating circuit the change with load may be in either direction (up or down .25% to full load and down or up .25% to no load).

RIPPLE

1% RMS maximum at 60 cycles. 2.5% maximum at 45 cycles.

Ripple specifications will be met at full load over the rated input voltage range and over rated output voltage adjustment at normal room temperatures. Ripple decreases as the load current decreases. Also, the percentage of ripple increases as the output voltage is decreased. Below 15°c. (59°F.) the ripple will increase and may be above 1%. At low temperatures the high initial ripple will be decreased as the unit warms up.

RECOVERY TIME

See Table I.

Recovery time is defined as the time constant of the unit or the time for the output to effect a 63% recovery from the maximum deviated value. The time required for the output to return to within 1% of the initial value is longer than this and is difficult to measure.

Load transients will cause the output voltage to change. The amount of change depends on the magnitude and rate of rise of the transient, and the amount of capacity across the output of the Nobatron. The Nobatron output voltage will begin to recover in .04 seconds or less. The magnitude of the voltage change may be reduced by adding additional capacitors across the output but this may increase the recovery time beyond the specified interval.

Line transients will also be attenuated by the filter capacitors as well as by the inductances of the magnetic amplifier and the filter choke.

AMBIENT TEMPERATURE RANGE AND DRIFT

+15°C. (61°F.) to +35°C. (95°F.)

Output voltage will not change more than .5% for changes of ambient from 15°c. to 35°C.

While operation at lower and higher temperatures is possible, regulation is not guaranteed outside these temperature limits. In addition, the ripple specification is not guaranteed below 15°C.

If operation above 35°C. is attempted, the life of various components will be reduced. In some cases, however, operation at reduced loads is possible at higher ambients. This of course is at the discretion and responsibility of the user.

After allowing 30 minutes for warm-up, drift at fixed ambient should not be more than .5%.

In the event the Nobatron is to be exposed to unusual temperature conditions, we suggest consultation with the factory for information concerning precautionary measures. At such times full details on the application should be forwarded to us.

TABLE I

ELECTRICAL SPECIFICATIONS

MODEL	MA6-5	MA6-40	SR28-15	MA28-50		
INPUT VOLTAGE RANGE	105-125			190-230 210-250 (1)		
FREQUENCY	60 cycles					
PHASE	1			3		
OUTPUT VOLTAGE ADJUSTMENT RANGE	5.40 - 6.60	4.50 - 7.70	5.0 - 32.0	23.0 - 32.0		
OUTPUT CURRENT	5	40	15	50		
REGULATION ACCURACY (Line and Load Combined)	±1%					
RIPPLE	1% RMS			3% RMS		
RECOVERY TIME	.15 sec.	.20 sec.		.50 sec.		
AMBIENT TEMPERATURE RANGE	15°C. (61°F.) to 35°C. (95°F.)					
INPUT CURRENT (Amperes)	2	12	15	15		
SENSING OR REFERENCE ELEMENT	Silicon Diode	Lamp Bulb	Silicon Diode			
CONTROL MAGNETIC AMPLIFIER	No	Yes				

(1) 210 or 230 nominal input by tap change.

TABLE II

MISCELLANEOUS SPECIFICATIONS

MODEL	MA6-5	MA6-40	SR28-15	MA28-50		
TYPE CONSTRUCTION	Rack Mounting	Bench Model		Floor Model		
DIMENSIONS Rack	19" Wide 5¼" High 11" Deep	19" Wide 12¼" High 16" Deep	19" Wide 14" High 16" Deep			
Cabinet or Bench	21¾" Wide 7" High 11½" Deep	17¾" Wide 12¼ High 16" Deep	17¾" Wide 14" High 16" Deep	17" Wide 28¾" High 15¾" Deep		
WEIGHT	30 lbs.	110 lbs.	130 lbs.	210 lbs.		
INPUT TERMINALS	Terminal Board Lower Left	Line Cord on Rear		Terminal Boards Right Rear		
OUTPUT TERMINALS		Terminal Post on Right Rear				
ON-OFF SWITCH	DPST			TPST		
OVERCURRENT PROTECTION	Input Fuse			Input Fuses		
METERS	Not Available	Optional		Standard		
PILOT LIGHT	Yes			No		
FAN COOLING	No			Yes		
VOLTAGE ADJUSTMENT	Screw Driver	Knob				

INSTALLATION INSTRUCTIONS

Smaller units are made for standard 19" relay rack or cabinet mounting. Medium units are bench models with removable side and rear panels. These models may be rack mounted by the addition of special brackets. Large units are floor models on casters on which front and rear doors are provided. These units are not designed for rack mounting.

Bench models have side handles which must be removed for rack mounting.

Mounting

To mount rack type units in rack or cabinet, it is necessary to remove the front panels to make the mounting slots accessible. Mounting hardware is provided.

Bench models are mounted in racks or a cabinet by means of a special bracket attached to the unit if ordered specially. Handles must be removed from the side panels before mounting the unit in a rack.

Terminals

On rack mounted units input and output connections are made at terminal boards located behind the removable front panel through grommet holes in the side lips of the chassis. See Table II. for the location of these terminal boards and for the type of terminals available on other units. A ground terminal is available on all units.

The wire size used in connecting a unit should be at least as large as that required to carry the input and output currents listed on the nameplate and Table II in accordance with applicable wiring codes covering the installation. It is recommended that even larger wire sizes be used on the output circuit in order to reduce the voltage drops between the terminals and load to a minimum.

Controls

An on-off switch is provided in all units. Even with the switch off, voltages still exist in the unit up to the switch terminals.

CAUTION: DO NOT TOUCH THE NOBATRON CIRCUITRY UNTIL THE INPUT POWER HAS BEEN DISCONNECTED EXTERNALLY BY A LINE SWITCH OR THE REMOVAL OF THE INPUT LINE PLUG FROM THE POWER OUTLET.

Output voltage is adjusted by means of a potentiometer (either screwdriver adjust or with knob.) Clockwise rotation increases the output voltage. A fine adjust potentiometer is provided in some units.

For safety reasons the user should provide a solid connection between the ground terminal post on the Nobatron and the electrical system ground. (Where a three wire input cable is provided all that is necessary is to connect the third wire to the system ground.)

Grounds

As no high voltages exist in the control circuit, units are shipped with the output floating. A ground terminal is provided, however, and either output terminal may be grounded.

Forced Air Cooling

Large three phase units are provided with fan cooling for the selenium rectifier. A thermal switch is provided on the rectifier to reduce the output voltage and limit the current in case of failure of the fan.

PRINCIPLE OF OPERATION

The operation of the unit can best be understood by referring to the schematic diagram furnished with each unit.

All components used together with their function, are listed below. (Note that any given model may not use all the components listed.)

R1	Resistance in series with the sensing or reference element forming non-linear voltage divider.
R2	Non-linear resistor or resistors used as sensing or reference element. This may be a semiconductor or a tungsten filament.

R3	Output voltage adjustment used to center adjustment range.
R4	Output voltage adjustment potentiometer.
R5	Output voltage fine adjustment potentiometer in series or shunt with R4 (not usually used).
R6	Output voltage fine adjustment limiting resistor to protect and limit range of R5, if used in shunt with R4.
R7 & R8	Sensing voltage divider resistors.
R9	Resistance in series with control coil on power amplifier for impedance matching.
R10	Bleeder resistor to provide minimum load on power amplifier and discharge condensers C1 and C2.
R11	Line compensating adjustment to control current in compensating windings of amplifier and compensating rectifier S3.
R12	Load compensating adjustment to control current in compensating winding of amplifier.
R13	Resistance in series with control coil on control amplifier for impedance matching.
R14	Resistance in series with bias winding on power amplifier to adjust bias.
R15	Resistance in series with pilot light.
R16	Ammeter shunt.
C1	Input filter capacitors. Usually consists of several capacitors in parallel.
C2	Output filter capacitors.
C3	Stabilizing capacitor for power amplifier.
C4	Stabilizing capacitor for control amplifier.
S1	Power rectifier — may also act as rectifier in self-saturating circuit.
S2	Self-saturating rectifier in control amplifier circuit.
S3	Compensating rectifier.
S4	Self-saturating rectifiers, if separate from S1.
L1	DC choke.
T1	Power self-saturating magnetic amplifier reactor.
T2	Input transformer.
T3	Control self-saturating magnetic maplifier reactor.
SW1	Input switch.
SW2	Rectifier thermal switch.
F1	Input fuse.
PL1	Pilot light.
A	Ammeter.
V	Voltmeter.
M	Fan motor.

The MA Nobatron consists of a power self-saturating magnetic amplifier followed by a filter circuit and a tubeless control circuit using non-linear resistance as a reference element (or elements) and except in smaller units a control self-saturating magnetic amplifier.

The power circuit consists of a transformer T2, the self-saturating reactor T1 and associated rectifiers S1 and S2. In the center tap and the three phase circuits S1 acts as the rectifier required for self saturation of the reactor as well as providing the DC output. In single phase bridge circuits, however, only two arms of the bridge rectifier (S2) act as self-saturating rectifiers, the other arms (S1) being used to assist in providing a DC output only. A third circuit is the AC doubler in which the magnetic amplifier with rectifier S2 is in the primary circuit of transformer T2 and provides AC output which is then transformed to the proper voltage and rectified by S1.

A detailed explanation of the theory of the magnetic amplifier is beyond the scope of this Manual. In simple terms, however, the AC coils on the reactor may be considered to act as "gates" which open at some time during the half cycle in which the rectifier S1 allows conduction. Until the gate opens, no current flows. After the gate opens current flows and is restricted only by the impedance of the load circuit. Thus the average current and hence the voltage is controlled by the fraction of the half cycle period that the gate is open. For example, if the input voltage is reduced, the current flow during the conducting period will be reduced. Therefore, the gate must be opened earlier to maintain the same output voltage.

Opening of the gate is controlled by the current in the DC windings of the reactor T1. The self-

saturating reactor differs from the older type reactors in that, with no control current, a large output current and voltage will result. Adding control ampere turns with the same polarity as the power ampere turns, as determined by the rectifier S1 or S4, will increase the output, and conversely, reducing the control ampere turns will decrease the output.

On most units the control current is supplied by a magnetic amplifier which only supplies current in one direction and requires the addition of a bias winding on the power reactor. The bias ampere turns reduce the output so that with no current in the control coil, it is less than the minimum voltage of the unit. Bias current may be a fixed current in series, or in shunt, with the sensing bridge, or may be a bias varying with the input voltage supplied through rectifier S3. In this case the bias windings also act as a compensating winding automatically changing the control ampere turns as the input changes, and reducing the ampere turns change required from the control circuit. Load compensating windings using a voltage drop across the filter choke, or a shunt, may also be used.

The control magnetic amplifier differs from the power magnetic amplifier only in that a better grade of iron is used giving higher gain. With this type of iron, essentially full output is obtained at zero ampere turns, so that no bias is necessary. Compensating windings may be used, however, which may require a fixed bias to balance out their average effect.

The sensing or reference element is some type of non-linear resistance; either a semi-conductor device such as a silicon diode operated in the reverse direction (high resistance or low conduction) or the tungsten filament of a lamp bulb. These non-linear devices have the property that as the voltage increases the resistance decreases and therefore the current increases faster than the voltage. If this change is great enough the non-linear element becomes a voltage reference holding a relatively constant voltage over a wide range of currents. This reference element, R1, is placed in series with a linear resistor R2 across the output of the unit. A slight change in output voltage causes a larger change in current. This change in current causes the voltage drop through R2 to change more than if R1 was also a linear resistance. The voltage across R1 thus changes less than if it were linear. Another voltage divider, R7, R8, both linear, is also placed across the output. The voltage drop across R8, which varies in proportion to the output voltage change, is compared with the voltage drop across R2, which varies only slightly, and the difference is used to supply the control current to control reactor T3 (or T1 if T3 is not used).

In some cases the diagonally opposite arm of the bridge R7 is also non-linear. This is only done if the voltage drop is the same across all arms of the bridge and R7 is called R2 and R8 is called R1.

Voltage adjustment is made by the adjustable resistor R3 and the potentiometer R4 which may be in series with the entire sensing network, R1, R2, R7, R8, or may be included as part of the bridge between R7 and R8. Moving the slider of R3 or R4 in the plus direction decreases the output voltage.

In *units with no control reactor T3,* the voltage across R8 (which includes the voltage to the slider of R3 or R4 if this is between R7 and R8) is less than the voltage across R2. If the output voltage decreases due to more load or lower input voltage, the voltage across R8 decreases more than the voltage across R2, increasing the control current, thus opening the gate earlier and bringing the output up to its original value, less the amount of change determined by the gain of circuit to make this change.

In *units with a control reactor T3,* the voltage across R8 is more than the voltage across R2. If the output voltage decreases, the control current decreases which increases the output current of the control stage which therefore opens the gate earlier and so on as explained in the preceding paragraph.

MAINTENANCE

During normal life, this instrument requires no maintenance other than the care afforded similar equipment. Since the life of rectifier stacks can be considerably reduced by restricting the air flow over the plates, it is suggested that excessive dust, etc., be removed periodically. At such time care should be exercised to prevent damage to the plates by cleaning tools or excessively strong air blasts.

Spare Parts

All components used in these Nobatrons are of a good commercial grade and can be expected to give a reasonably long period of trouble-free service. As the age of the instrument increases, however, some components are likely to deteriorate; we therefore suggest that the customer contact our Service Department for a list of the parts that should be kept on hand.

In the event it becomes necessary to replace any part we strongly suggest that the replacement parts be of the same value as the original. Substitute parts should not be used unless we advise that the substitute part will not impair the performance of the instrument.

TROUBLE SHOOTING

CAUTION

DANGEROUS VOLTAGES EXIST IN THIS INSTRUMENT. PLEASE OBSERVE APPROPRIATE PRECAUTIONS.

Typical circuit voltages and currents including direction of current are indicated on the schematic drawing supplied with each unit. All voltage measurements should be taken with a 1000 ohms per volt meter. All current readings should be taken with as low a resistance meter as possible.

SYMPTOM A — NO OUTPUT VOLTAGE

POSSIBLE CAUSE	Check:
AN OPEN IN THE POWER CIRCUIT	Test for an open circuit in one of the following components: on-off switch, fuse, primary and secondary of transformer T2, AC windings of reactor T1, rectifier S1, Choke L1.

SYMPTON B — HIGH OR LOW OUTPUT VOLTAGE

This is probably due to failure of the sensing element or failure of the control reactor circuit. The first thing to check is the voltage across sensing element R2.

If the voltage across R2 is normal, then make the following checks:

POSSIBLE CAUSE:	Check:
CONTROL REACTOR GIVING LOW OR HIGH VOLTAGE	If the output is low, determine if the voltage is being applied to the circuit. Check current in the output of the reactor. Low output is due to no current or low current which may be caused by open rectifier S2, or open coils on T3. High output is caused by high current which may be caused by an open DC winding or an open circuit between the DC winding and the sensing bridge.

SYMPTOM C — HIGH RIPPLE

This is due to the failure of one or more of the electrolytic capacitors. Check the ripple voltage across C1. If this is normal or lower, failure is in the output bank (C2). If this is high, failure is in the input bank (C1).

SYMPTON D — HUNTING OR OSCILLATION OF OUTPUT

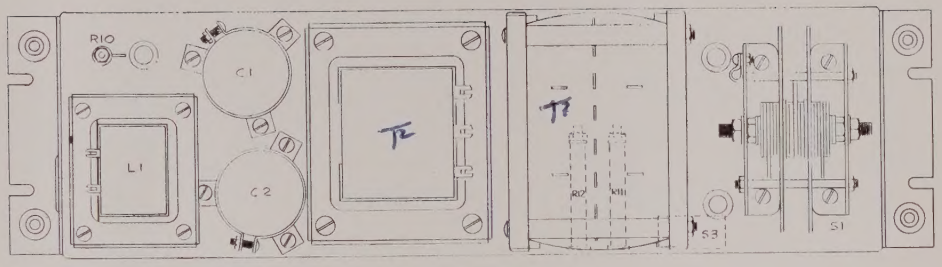
This is due to the failure of the anti-hunt circuits utilizing capacitors C3 and C4 feeding back to coils on T1 and T3.

Check capacitors and windings on T1 and T3.

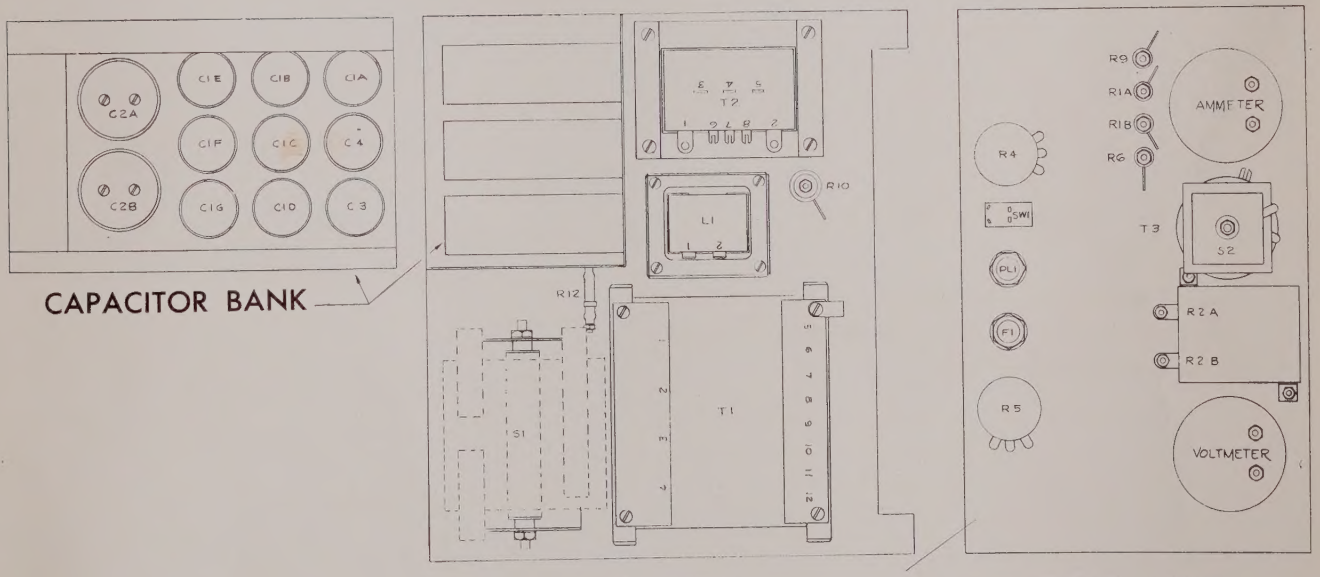
FILTER CAPACITORS

In the event one or more input filter capacitors (C1) fail, they should be replaced at once or else the load on the Nobatron should be reduced in proportion to the amount of capacity removed. If this precaution is not observed premature failure of the remaining input capacitors may result.

IN THE EVENT OF SERIOUS DIFFICULTY OR DAMAGE TO THE NOBATRON WE SUGGEST THAT CONSIDERATION BE GIVEN TO RETURNING IT TO THE FACTORY FOR REPAIR.



REAR VIEW
MODEL MA-65



TOP VIEW

FRONT PANEL
REAR VIEW

MODEL MA-640

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